ELSEVIER

Canadian Association of Radiologists Journal 60 (2009) 190−195

CANADIAN ASSOCIATION OF RADIOLOGISTS JOURNAL

www.carjonline.org

Magnetic Resonance Imaging / Formation image de résonance magnétique

Evaluation of Adult Outpatient Magnetic Resonance Imaging Sedation Practices: Are Patients Being Sedated Optimally?

Janel E. Middelkamp, MD[a], Bruce B. Forster, MD, FRCPC[b,*], Ciaran Keogh, MB, MRCPI, FFRRCSI[c], Pamela Lennox, MRCPI, FCARCSI[d], Kelly Mayson, MD, FRCPC[d]

[a]*University of British Columbia Diagnostic Radiology Residency Program, Vancouver, British Columbia, Canada*
[b]*Department of Radiology, Vancouver Hospital, UBC Site, Vancouver, British Columbia, Canada*
[c]*Brooke Radiology, Burnaby, British Columbia, Canada*
[d]*Department of Anesthesia, Vancouver Hospital, Vancouver, British Columbia, Canada*

Abstract

Purpose: To evaluate the use of anxiolytics in adult outpatient magnetic resonance imaging (MRI) centres and to determine whether utilisation is optimal based on the pharmacology of the drugs used, who prescribes these drugs, and how patients are managed after administration.
Materials and Methods: Identical paper and Web-based surveys were used to anonymously collect data about radiologists' use of anxiolytic agents for adult outpatient MRI examinations. The survey questions were about the type of facility, percentage of studies that require sedation, the drug used and route of administration, who orders the drug, timing of administration, patient monitoring during and observation after the study, use of a dedicated nurse for monitoring, and use of standard sedation and discharge protocols. The χ^2 analysis for statistical association among variables was used.
Results: Eighty-five of 263 surveys were returned (32% response rate). The radiologist ordered the medication (53%) in slightly more facilities than the referring physician (44%) or the nurse. Forty percent of patients received medication 15−30 minutes before MRI, which is too early for peak effect of oral or sublingual drugs. Lorazepam was most commonly used (64% first choice). Facilities with standard sedation protocols (56%) were more likely to use midazolam than those without standard sedation protocols (17% vs 10%), to have a nurse for monitoring ($P = .032$), to have standard discharge criteria ($P = .001$), and to provide written information regarding adverse effects ($P = .002$).
Conclusions: Many outpatients in MRI centres may be scanned before the peak effect of anxiolytics prescribed. A standard sedation protocol in such centres is associated with a more appropriate drug choice, as well as optimized monitoring and postprocedure care.

Abrégé

But: Examiner l'utilisation d'anxiolytiques chez les patients adultes externes de centres d'imagerie par résonance magnétique afin de déterminer s'ils sont administrés de façon optimale eu égard à l'action des médicaments, au prescripteur des médicaments ainsi qu'au type de suivi postadministration.
Matériel et méthodes: Les données sur l'utilisation, par les radiologistes, d'agents anxiolytiques sur des patients adultes externes devant subir des examens d'IRM ont été extraites de questionnaires en version papier et en ligne remplis sous le couvert de l'anonymat. Les questions visaient à connaître le type d'établissement, la proportion d'examens nécessitant une sédation, le médicament utilisé et le mode d'administration, le prescripteur, le moment où les médicaments sont administrés, la surveillance pendant et après l'examen, l'utilisation du personnel infirmier pour la surveillance et l'application de protocoles de sédation et de sortie. Une analyse χ^2 a été effectuée pour établir les associations statistiques entre les variables.
Résultats: Quatre-vingt-cinq des 263 questionnaires ont été retournés, ce qui représente un taux de participation de 32 %. Le nombre d'établissements où la sédation a été prescrite par le radiologiste (53 %) est légèrement supérieur à celui des établissements où le médecin

* Address for correspondence: Bruce B. Forster, MD, FRCPC, Department of Radiology, Vancouver Hospital, UBC Site, 2211 Wesbrook Mall, Vancouver, British Columbia V6T 2B5, Canada.
E-mail address: Bruce.Forster@vch.ca (B. B. Forster).

doi:10.1016/j.carj.2009.06.002

orienteur (44 %) ou le personnel infirmier s'en est chargé. Dans 40 % des cas, le médicament a été administré au patient de 15 à 30 minutes avant l'IRM, soit trop tôt pour que les médicaments oraux ou sublinguaux agissent de façon optimale au moment opportun. Le lorazepam est le médicament le plus prescrit (premier choix dans 64 % des cas). Les établissements qui obéissent à des protocoles de sédation (56 %) sont plus susceptibles d'utiliser du midazolam que ceux qui n'en ont pas (17 % contre 10 %), de confier la surveillance au personnel infirmier ($P = 0{,}032$), d'avoir des critères standards de congé de patients ($P = 0{,}001$) et de fournir des renseignements écrits sur les effets indésirables des médicaments ($P = 0{,}002$).

Conclusions: Bon nombre de patients externes des centres d'IRM passent leur examen avant que les anxiolytiques prescrits n'aient atteint leur effet maximal. Le protocole de sédation en vigueur dans ces centres vise principalement l'administration des médicaments les plus appropriés ainsi que l'optimisation de la surveillance et des soins postintervention.

Key Words: Sedation; Adults; MRI

Sedation is commonly used in radiology for both diagnostic examinations and interventional procedures. There are very few studies in the imaging literature regarding use of sedation for magnetic resonance imaging (MRI) and what is available pertains largely to pediatrics. To our knowledge, the current study is the first to evaluate radiologists' practices with respect to adult MRI outpatient sedation, which is an important topic, because suboptimal sedation of patients may not only lead to poor clinical outcome but may also place patients at serious risk. A previous review suggests that anywhere from 4%–30% of patients undergoing MRI examinations can experience anxiety-related reactions, which range from apprehension to severe reactions that interfere with the performance of the examination [1]. If patients are inadequately sedated, then the MRI examination is more likely to be nondiagnostic, because of motion, and may also result in increased procedure time. Oversedation of patients may result in extended recovery periods, an increased rate of complications [2], severe injury as outlined by a case report in which an MRI outpatient facility and family physician were found negligent in oversedating a patient with lorazepam [3], or possibly even death.

Evidence from prior research shows that radiology residents may not have an optimal working knowledge of the pharmacokinetics of the drugs most commonly used in radiology [4], accordingly, the drugs commonly used for sedation in MRI of adult outpatients may be administered in suboptimal doses and/or at inappropriate times relative to the examination. Our goal in this study was to evaluate the use of anxiolytics for this purpose and determine whether utilisation is optimal based on the pharmacologic properties of the drugs used. Also, we wished to determine who generally prescribes and administers these drugs and how patients are monitored and discharged after their administration.

Materials and Methods

Both paper and electronic surveys were used to collect data regarding radiologists' use of anxiolytic agents for MRI examination of adult outpatients. The paper survey was distributed to all attendees at an international radiology conference held in Whistler, Canada, in 2005, as well as a second international radiology conference held in Vancouver, Canada, in 2006. Based on the substantially different subject material of these 2 conferences, duplicate attendees were unlikely. In each case, conference attendees were asked to ensure that only one survey per practice group was submitted. An electronic survey was created by using Quask FormArtist software (New Canaan, CT), and a link to the Web-based form was distributed via e-mail to 55 Canadian radiologists who had indicated that they perform adult MRI, based on the Canadian Association of Radiology database. Only one electronic survey was sent to each represented institution. The e-mail was sent 4 times over a 3-month period. Both versions of the survey consisted of the same 17 questions, which included a mixture of yes-no, fill-in the blank, and forced choice formats (see Appendix 1).

The results of both the paper and electronic surveys were collected anonymously. Statistical analysis of response data consisted of χ^2 evaluation to look for association between categorical variables.

Results

A total of 208 paper surveys were distributed, and 62 completed surveys were returned. One of the 62 paper surveys was not included in the analysis because it was completed by a pediatric radiologist. The adjusted response rate for the paper arm of the survey was 29%. Twenty-four of the 55 radiologists who received the e-mail link to the Web-based version responded, for a 44% response rate for the electronic arm of the survey. In total, 85 of 263 surveys were returned for an overall response rate of 32%.

Nearly half of respondents, 49%, practiced in a community hospital, whereas 27% practiced in an academic hospital and 14% in a clinic. The remainder indicated that their practice incorporated a combination of these settings. The vast majority of the facilities surveyed, 80%, used closed configuration magnets, with 5% using only open-configuration units. The remainder used a combination of different configurations, and no site used only an extremity magnet.

The percentage of patients who required sedation at each facility surveyed is summarized in Figure 1. Although the majority of all respondents indicated that fewer than 5% of

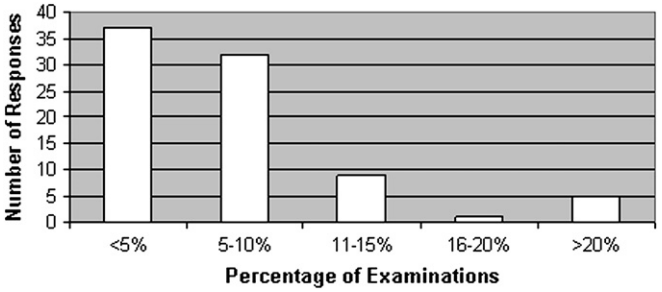

Figure 1. Percentage of outpatient MRI examinations that required anxiolytic medication at each of facilities included in survey.

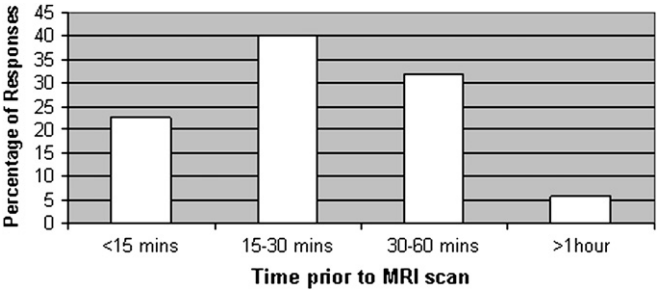

Figure 3. Length of time between administration of anxiolytic drug and commencement of MRI scan.

patients imaged at their facility required sedation, when these data were broken down by type of facility (Figure 2), academic hospitals had a statistically significant association with a higher percentage cohort of outpatients who required sedation (>20%) than nonacademic hospitals (5%–10%) or free-standing clinics (<5%) ($P = .019$).

Not all of the respondents answered all parts of the questions regarding drug choice, dose, and route of administration. Of the 77 respondents who did rank medications listed on the survey, 64% indicated that lorazepam was their first choice of anxiolytic for the purpose of sedation, and 17% said that diazepam was their preferred choice, whereas 14% indicated that midazolam was their preferred drug. No respondents ranked oxazepam as their first choice. Other drugs listed in the space provided were alprazolam (Xanax; Alprazolam; Pfizer, New York, NY) (5 radiologists), propofol (2), and triazolam (Halcion; Triazolam; Pfizer) (1).

Of those indicating the typical dose of lorazepam administered (47 individuals), 64% of respondents used 1 mg. For all anxiolytics, the choice of route was equally split between oral and sublingual administration (25 vs 24, respectively), with only one respondent choosing to use the intravenous (IV) route. The majority of patients (40%) received anxiolytics 15–30 minutes before their MRI (Figure 3). No correlation existed between the oral vs the sublingual route of administration and the timing of the scan for those facilities that used lorazepam ($P = .431$). A statistically significant relationship did exist between the IV administration of diazepam and a period of less than 15 minutes before the start of the scan ($P = .031$), which indicated that the IV form of diazepam was appropriately given closer to the start of the MRI examination than the oral form.

The radiologist ordered the medication most commonly in slightly more facilities (53%) than the referring physician (44%) or a nurse (1%). A nurse was most commonly the individual actually administering the medication (45%), with the technologist being the second most likely (25%). The patients who were receiving anxiolytics were monitored while in the magnet in 60% of the facilities surveyed. A dedicated nurse was available for monitoring these patients in 52% of facilities. Half of the respondents indicated that patients who received anxiolytics were monitored for a period of time after the MRI study. The majority of these patients were monitored for 30–60 minutes (Figure 4). Fifty-five percent of facilities had standard discharge criteria in place, and all but 2 respondents indicated that these criteria were routinely followed. A total of 74 of the 85 radiologists indicated that instructions were given to patients who received anxiolytic medication that they must be accompanied home. Only 36% of the facilities provided written information to patients before leaving the facility regarding adverse effects, driving, and when to contact a physician.

Fifty-six percent of the facilities had a standard sedation protocol in place. These facilities were more likely than those without standard protocols to use midazolam (17% vs 10%), although this relationship was not statistically significant. The facilities with a standard sedation protocol in place were also more likely to have a nurse for monitoring ($P = .032$), to have standard discharge criteria ($P = .001$), and to provide written information to patients regarding adverse effects ($P = .002$). No statistically significant differences were found for these parameters when comparing academic centres with community hospitals or clinics.

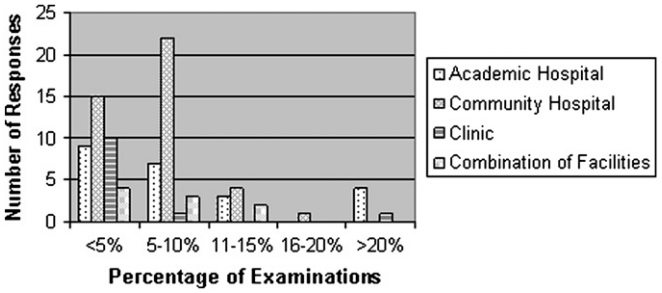

Figure 2. Percentage of outpatient MRI examinations that required anxiolytic medication, by type of facility.

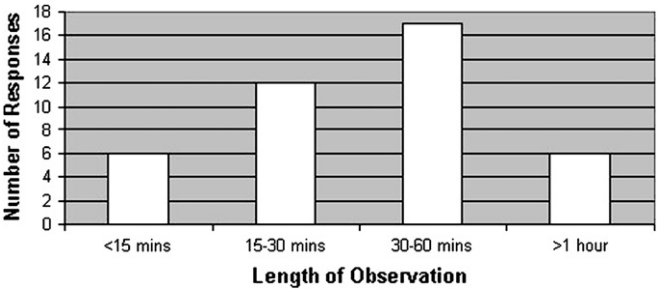

Figure 4. Length of observation for patients who received anxiolytic medication after completion of MRI scan.

1. Appropriate dose of lorazepam (see text) to be given 60-90 minutes prior to scan time.
2. *Patients should receive instructions, written if possible, to not drive, and to be accompanied by a responsible adult.
3. Monitoring with pulse oximeter inside MR unit is not required, unless patient has history of morbid obesity, sleep apnea, or history of moderate/severe cardiac, pulmonary, hepatic, renal, or CNS insufficiency, in which case patient is at increased risk of complications and should be monitored with pulse oximeter.
4. *Post-examination, patient can be discharged as long as they can ambulate without difficulty (or at pre-anxiolysis level).
5. *The patient should be accompanied out of the department by a responsible adult.
6. *Patient should receive written instructions prior to discharge to not operate vehicles or dangerous equipment for up to 24 hrs, and to avoid other sedatives, including alcohol, also for up to 24 hrs.
7. *Many hospitals/outpatient centres have existing sedation/anxiolysis protocols, and consideration of those protocols in addition to the above points is strongly recommended.

Figure 5. Suggested protocol for oral anxiolysis for MR outpatients.

Discussion

Our data demonstrate that it was the radiologist who prescribed the anxiolytic medication in just over half of the MRI outpatient facilities included in the survey, which stresses the importance of radiologists having a good understanding of the pharmacologic properties of the drugs most commonly used for adult outpatient sedation. The American Society of Anesthesiologists published guidelines for the use of sedation and analgesia by nonanesthesiologists [5], and the American College of Radiology developed practice guidelines for the use of adult sedation and analgesia in radiology [6]. Both of these sets of guidelines outline the need for appropriate knowledge regarding the use of medications and the treatment of potential adverse effects. They also discuss the types of monitoring and personnel required for safe administration of these drugs. Neither of these guidelines discusses specific drugs or drug classes. Thus, radiologists must look to other sources to find information about the specific drugs used for sedation in the radiology department. Unfortunately, most Canadian residency programs do not have formal training about the pharmacology of the drugs used most commonly [4].

In the facilities surveyed, most patients received the anxiolytic agent of choice 15–30 minutes before their scans were performed, and lorazepam was most commonly prescribed. Lorazepam (Ativan; Wyeth, Markham, Canada) is a long-acting benzodiazepene. For both the oral and sublingual forms, the onset of effect is as long as 60–90 minutes [4] with peak onset of action at 120 minutes; contrary to widely held opinion, sublingual lorazepam does not have a significantly faster onset of action [7]. Typical doses used for lorazepam are 0.5–1 mg, and this drug has a variable duration of action, with a prolonged amnestic effect [8]. The elimination half-life is 15 hours. Based on these properties, the ideal time for administration of this drug would be more than 1 hour before an MRI examination, not the 15–30 minutes most commonly reported in our study. Our data also show no correlation between time and route of administration of this agent; patients who received the drug sublingually were not scanned earlier than those who received it orally. It is possible, therefore, that many patients in the facilities surveyed received marginal benefit from the administered lorazepam, regardless of mode of administration, and that the peak onset of anxiolysis occurred after the MRI scan had been completed.

1. Sedation is only to be administered by a nurse or physician, familiar with the pharmacology of the selected agent(s).
2. Patient should have ingested no solids for 6 hrs prior to the examination, and no clear fluids for 2 hrs prior to the examination.
3. Current medications, including illicit drug use/history of abuse/drug allergies, and use of opiate analgesics in the last 6 hrs should be recorded.
4. Establish continuous monitoring for oxygen saturation, blood pressure and pulse. Initiate reliable IV access.
5. Assess baseline pulse, BP, respiratory rate, level of consciousness, oxygen saturation and weight.
6. Resuscitation equipment, including but not limited to oral and pharyngeal masks, mask and ventilation bag, suction, oxygen, and medications to reverse the effects of IV anxiolysis (Flumazenil is a benzodiazepine receptor antagonist) must be available.
7. Assess and document by nurse or physician every 5 minutes, during IV medication titration, and every 15 minutes thereafter during examination, oxygen saturation, pulse, BP, respiratory rate, and level of consciousness.
8. Notify physician immediately if patient is difficult to verbally arouse, respiratory rate <8/min, oxygen saturation <90%, or patient becomes brady or tachycardiac, or hypotensive.
9. Post-procedure monitoring as above should continue every 15 minutes until patient is alert. Vital signs should be within 20% of pre-procedural baseline prior to discharge.
10. Sufficient time (up to 2 hrs) must have elapsed after admission of reversal agents to ensure that patients do not become re-sedated after reversal effects have abated.

See references 5–8 for more discussion of protocol details.

Figure 6. Suggested protocol for on-site IV anxiolysis for MR outpatients, in addition to baseline protocol points (*) noted in Figure 5.

Diazepam is a long-acting benzodiazepine that can be given via multiple routes but is typically administered as an IV lipid emulsion (Diazemuls; Pfizer, Kirkland, Canada). It is available as a 5 mg/mL solution and is generally given in 2.5- to 5-mg increments [7]. Its onset of action is 2–3 minutes. If administered orally, peak blood levels are reached in 60 minutes in adults and within 15–30 minutes in children. The elimination half-life is 21–37 hours, and this drug can be associated with a hangover effect because of an active metabolite, desmethyldiazepam [8].

Midazolam (Sandoz, Boucherville, Canada) is a short-acting benzodiazepine that is administered by IV. This drug is typically given in 0.5- to 1-mg increments until the desired effect is reached. The onset of effect is usually within 2 minutes, and the duration of action is between 45 and 60 minutes [4]. These features make midazolam a more appropriate choice of anxiolytic agent for the purpose of outpatient sedation. The rapid onset of this medication also makes it easier to titrate the dose to meet the needs of individual patients. Our data show a trend towards an association between the use of midazolam and centres that have a standard sedation protocol in place. Centres with standard sedation protocols were also more likely to have a dedicated nursing staff for monitoring patients who receive sedation. Not only might this optimize patient safety but the availability specialized nursing staff has been shown to reduce the variability and costs associated with sedating patients [2]. The primary disadvantage of midazolam use is its IV route of administration. The IV preparation of midazolam can be used orally when mixed with a solution, such as liquid acetaminophen, to mask its bitter taste. Although widely used in anesthesia as premedication at a dose of 0.5 mg/kg in the pediatric population, with a maximum dose of 20 mg oral in

both adults and children, this oral administration would be considered off-label use in North America [9,10].

We, therefore, would recommend that, for adult outpatients who require anxiolysis for the MRI, if oral or sublingual lorazepam is to be used, then it should be given 60-90 minutes before the anticipated start time of the patient's scan. Alternatively, IV administration of midazolam could be undertaken onsite but should be used only by those familiar with its pharmacology and with a sedation monitoring protocol in place (see Figures 5 and 6 for an example of a sedation protocol).

Potential limitations of our study design include the use of the electronic format for part of the survey. The response rate for electronic surveys is less than for fax- and mail-based surveys [11] and is in the range of 35% [12,13], hence the need for the 4 e-mail requests in the electronic arm. The Web-based survey may be biased to the type of individual more likely to respond; that is, those who use computers more frequently and those who are more technologically inclined. The potential benefits of this type of survey, however, are the lower cost and faster rate of response [11,14]. Although we had a higher response rate for the electronic version than for the paper version of the survey (44% vs 29%, respectively, for an overall response rate of 32%), this may be because the Web-based survey was sent to a target population known to have an interest in MRI, whereas the paper survey was handed out to all attendees at two conferences. The survey design, especially the forced-choice format, does not account for the necessary flexibility and variability in protocols required for patients with individual needs, such as those with systemic health problems or those taking other medications. Our sample size is relatively small, in part, because of the difficulty in obtaining an MR radiologist database in North America.

In conclusion, our data demonstrate that it is the radiologist who most commonly orders anxiolytic medication in more than half of the adult outpatient MRI centres included in our survey. Therefore, there is a need for a thorough understanding of the pharmacology of the drugs used, including optimal timing and dosage. Based on our small study, many adult outpatients undergoing MRI examinations may be scanned before the peak effect of anxiolytics prescribed in outpatient centres. A standard sedation protocol in such centres is associated with more appropriate drug choice, plus optimized monitoring and postprocedure care.

References

[1] Melendez JC, McCrank E. Anxiety-related reactions associated with magnetic resonance imaging examinations. JAMA 1993;270:745–7.
[2] Bluemke DA, Breiter SN. Sedation procedures in MR imaging: safety, effectiveness, and nursing effect on examinations. Radiology 2000;216:645–52.
[3] Berlin L. Sedation and analgesia in MR imaging. AJR Am J. Roentgenol 2001;177:293–6.
[4] Mayson K, Lennox P, Anserimo M, et al. Canadian radiology residents' knowledge of sedation and analgesia: a Web-based survey. Can Assoc Radiol J 2006;57:35–42.
[5] American Society of Anesthesiologists Task Force on Sedation and Analgesia by Non-Anesthesiologists. Practice guidelines for sedation and analgesia. Anesthesiology 2002;96:1004–17.
[6] American College of Radiology (ACR). ACR practice guideline for adult sedation/analgesia. Revised 2005. Available at: http://www.acr.org/s_acr/bin.asp?TrackID=&SIS=1&DID=12184&CID=1076&VID=2&DOC=File.PDF. Accessed September 28, 2007.
[7] Repchinsky C. Compendium of Pharmaceuticals and Specialties, The Canadian Drug Reference for Health Professionals. 9th ed. Ottawa, ON: Webcom Limited; 2006. 224–6 and 667–8.
[8] Martin M, Lennox P. Sedation and analgesia in the interventional radiology department. J Vasc Interv Radiol 2003;14:1119–28.
[9] McMillan CO, Spahr-Schopfer IA, Kikich N, et al. Premedication of children with oral midazolam. Can J Anaesth 1992;39:545–50.
[10] Brosius KK, Bannister CF. Oral midazolam premedication in preadolescents and adolescents. Anesth Analg 2002;94:31–6.
[11] McMahon SR, Iwamoto M, Massoudi MS, et al. Comparison of e-mail, fax, and postal surveys of pediatricians. Pediatrics 2003;111:299–303.
[12] Jones R, Pitt N. Health surveys in the workplace: comparison of postal, email and World Wide Web methods. Occup Med (Lond) 1999;49:556–81.
[13] Seguin R, Goodwin M, MacDonald S, et al. Email or snail mail? Randomized controlled trial on which works better for surveys. Can Fam Physician 2004;50:414–9.
[14] Raziano DB, Jayadevappa R, Valenzula D, et al. E-mail versus conventional postal mail survey of geriatric chiefs. Gerentologist 2001;41:799–804.

Appendix 1. MRI Sedation Survey

FACILITY

1. What type of practice are you involved in?*
   Academic Hospital Community Hospital Clinic
2. What type of unit does your practice use?
   Open configuration Closed Configuration Extremity only

SEDATION QUESTIONS

1. Is there a standard protocol for outpatient sedation in your unit? Yes No
2. Estimate what percentage of outpatient examinations performed at your facility requires sedation:
   <5% 5%–10% 11%–15% 16%–20% >20%
3. How long in advance of the study does the patient typically receive the sedative?
   <15 mins 15–30 mins 30–60 mins >1 hour
4. Which is/are your drug(s) of choice? (Please rank in order of preference if you use more than 1)

Rank	Drug	Dose	Route
____	Lorazepam/Ativan	0.5 mg 1 mg 2 mg 3 mg	po sl iv
____	Oxazepam/Serax	15 mg 30 mg	po iv
____	Diazepam/Valium	5 mg 10 mg po iv	(Diazemuls)
____	Midazolam/Versed	1 mg 2 mg 3 mg 4 mg	iv
____	Fentanyl	25 μg 50 μg 75 μg 100 μg	iv

Other (please specify drug, dose, and route): _____

* If you are involved in more than 1 practice type, or if your practice utilises more than 1 type of MR unit, please provide answers based on where you spend the majority or your time and/or which unit produces the majority of the studies you evaluate.

5. Who usually orders the drug?
   Referring Physician Radiologist Nurse
6. Who usually administers the drug?
   Referring Physician Radiologist Resident Nurse Technologist
7. Is there a dedicated nurse for monitoring the patient?
   Yes No
8. Are sedated patients routinely monitored in the magnet?
   Yes No
9. Are sedated patients routinely monitored for a set period of time following the MR study?
   Yes No, discharged home immediately following the study
10. If you answered ''yes'' to question 9, how long are patients observed following the MR study?
    <15 mins 15–30 mins 30–60 mins >1 hour
11. Does your facility have standardized discharge criteria for postsedation patients?
    Yes No
12. If so, are these criteria routinely followed? Yes No
13. Must all patients who receive sedation be accompanied home?
    Yes No
14. Is any written information provided to patients prior to leaving the facility regarding side effects, driving, when to contact a physician, etc?
    Yes No
15. Is any formal teaching of sedation and related pharmacology to your program's residents?
    Yes No Not sure N/A (nonacademic center)